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DEVELOPMENT AND IMPROVEMENT OF PORTS

Guidelines for port managers on the use of computers

Report by the UNCTAD secretariat

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READEX

Introduction

1. This report has been prepared following the recommendation of the *Ad hoc* Intergovernmental Group of Port Experts to prepare a study on data processing in the domain of port operations and documentation, which was agreed to by the Committee of Shipping at its twelfth session in section II of resolution 60(XII). The purpose of this publication is to advise senior and especially middle port managers in developing countries on how to make the best use of modern information technology. However, this subject, which is of key importance for the development and operation of modern ports is complex. It is planned therefore to supplement this report by another giving a more detailed description of systems which can be implemented in ports in developing countries.

2. Innovations in technology are changing the economics of processing, storage and distribution of information. Over the last 20 years or so the cost of computer power has been reduced by a factor of about 10,000 and the cost of producing software has been reduced about 100 times over the same period. These innovations have also changed the organizational structure of data processing with computing capacity being decentralized throughout the firm. In the past there was only a small group of specialists who dealt with data processing but now a growing number of staff are using personal computers or terminals linked to larger computer systems in their daily work. A recent survey on computer software noted that while there were 35,000 to 40,000 IBM mainframe computers, there were over 10 million IBM and IBM-compatible personal computers in the world. Managers need to understand what the technology can do for them and how it can be used, rather than understanding the technology itself.

3. Information technology is now becoming an essential part of the global economy which depends for its functioning on the rapid and accurate transfer and processing of enormous volumes of data. The rapid movement of large volumes of cargo through modern ports depends on the timely processing and communication of a correspondingly large quantity of information. The proper management of systems which process this information and communicate it to those who manage port operations is vital for efficient transport. The rapid development of computers and telecommunications and the fusion of the two technologies has made possible the development of systems that can provide information to the business manager which is more complete, more timely, and more accurate than was possible with the previous manual or mechanized systems.

4. Proper use of modern information systems confers competitive advantages on their users. Almost any business, and certainly most ports, can benefit from the better control which can be exerted with modern information systems. Although some "high-tech" systems have received much publicity it should not be forgotten that quite modest, inexpensive and simple systems can provide considerable benefits.

5. The integration of telecommunications with computers has affected shipping and freight forwarding more than port management, which tends to be mainly concerned with loading and discharging operations within the port rather than the transport of cargo over long distances. However, the provision of a good telecommunications facility in the immediate vicinity of the port area is an important factor for the effective planning of ship working and cargo dispatch, thus making the port more competitive.

6. While the place of the port in maritime cargo transport is clear, it is not so obvious what role the port should now play in the processing and transmission of information related to cargo and shipping. This topic is complex and depends on national policy as well as international arrangements. Besides those firms directly involved in the movement of the cargo, other organizations, such as customs and banks, participate in the transmission of information. Port managers need to consider their relations with all other users of this information to ensure both that they get the information that they need and also that the port occupies an appropriate place in the processing and transmission of information related to the cargo that it handles.

7. This could extend in some cases to providing a central data bank for use by the other organizations involved, including shipping agents, road haulage and railways. Some ports in developed countries have developed data bases in response to competition as a means of improving service to clients. Ports in developing countries which often enjoy a monopoly position do not have the same incentive. However, they should be aware that their country is developing in a global competitive environment, where any reduction in logistics costs may reduce import prices or open up new markets for exports. In addition, those ports which hope to become a hub or transhipment port may seek to develop such facilities as part of their package and to assure high levels of service

on their terminal. This topic is not treated further here beyond saying that in port information processing systems, use of national and international standards should be made whenever possible to ease the connection of the port system to the other system when required.

8. Developments in computer equipment (hardware) have resulted in a large selection of computers with different capacities for different applications. This hardware maybe classified by function and processing power into three main groups: microcomputers (single-user, frequently called personal computers), minicomputers (tens of users) and mainframe computers (hundreds of users and high capacity). Nowadays, for most commercial applications, including those in ports, microcomputers and minicomputers offer sufficient capacity. These computers can also be linked together in a network using a communication package which gives the ability to share and exchange information. Access to the computer system is mainly via terminals with a keyboard and a screen. The range of costs for this equipment varies from a couple of thousand dollars to a couple of hundreds of thousand dollars. This selection allows organizations to start out small and subsequently upgrade the system through the purchase of additional equipment.

9. The processing capabilities of individual microcomputers continues to increase considerably. Microcomputers, especially with word processing and software packages, can be an initial low-cost investment in those ports having little or no experience with computerization. Initially they can be used to support the work of individuals within the organization. As computing needs grow, individual micros can be linked into a network giving the possibility to exchange and share information. Finally this network of micros can be integrated into a mini or mainframe computer system when data files or processing needs grow. The provision of microcomputers to those most likely to use them is one way to develop a visible corps of computer-literate professionals, making subsequent implementation of larger computer systems easier.

10. It is not widely appreciated that purchasing hardware is not the main problem in applying computer technology to information systems; rather the problems are those of acquiring adequate software (programs) with a good human interface and of organizing the whole information system. Many plans and policies continue to be formulated in terms of the hardware, with the software being regarded as an adjunct. ***Far more attention should be paid to the software.*** There is a large selection of various types of software available on the market offered by both computer manufacturers and independent suppliers. The software can be classified into general purpose packages, system software and application systems. *General purpose packages* include word processors, spread sheets, simple databases and communication programs. These packages are very popular on microcomputers, are user-friendly and are rapidly implemented. *System software* is normally supplied by the computer manufacturer and consists of different types of operating systems which are the interface between hardware and other software used on a particular computer and sophisticated software packages like programming languages, complex data bases and communication packages which are used by professional staff to develop application packages. *Application systems* include individual computerized systems like invoicing, payroll and container control. These systems are developed using the database packages and/or by writing programs in one of the programming languages.

11. Another crucial area to consider when analysing the computerization of information systems is the environment. This includes such factors as reliability of power supply, quality of telecommunication services, availability of hardware and software maintenance and availability of systems analysts, programmers and other skilled staff. Lack of properly trained and experienced computer specialists has been one of the most serious barriers to the adoption of modern information technology, mainly because production of software for computers has been labour intensive and because, in the past, technical knowledge was essential to make effective use of computers. There are signs that this situation is improving, both because the hardware is so cheap that efficient use of hardware by the software is no longer always a prime consideration and also because recent developments are making software production less costly and the software more "friendly" to use.

12. As a result of the enormous increase in power and equally enormous reduction in cost of computer equipment in the last few years, there has been a vast increase in the capacity to store, process and transmit information, although the ability to make good use of the hardware has not always kept up. Proper selection of computer systems taking into consideration environment, software and hardware will assure the effective development of computerized systems within the port. This choice of both hardware and software allow organizations to start out small and then grow. The development of information technology now allows managers to make more effective use of their information resources than ever before.

I. Information for managers

A. General considerations

13. The information which a manager requires to do his job comes from many sources, including informal sources like a walk round the premises and conversations. A manager also uses systems specifically designed and operated to provide the information that he requires to control the business, such as accounting systems, inventory control systems, etc. Sometimes the systems that a manager uses receive information from and/or transmit information to other organizations. The efficient operation of these kinds of systems is becoming more important to the port manager as cargo movement becomes faster. The rapid development of computers and telecommunications has made possible the development of information systems that are cheaper, faster, of greater capacity, of wider scope and much more flexible than was possible with the previous manual or mechanized systems.

14. Computerized systems are becoming of increasing importance in ports and shipping where developments in the technology of cargo handling make it essential to process and transmit rapidly the large volume of documentation which accompanies the international shipment of goods. Although some of the largest benefits of using modern digital technology in the ports and shipping business stem from its application to the documentation for shipment, it should not be forgotten that almost any business, and certainly most ports, can benefit from the better control which can be exerted with modern information systems.

15. The kind of information system that we are considering exists for a purpose: this purpose is either to provide information required by the manager to control the operation of another system or to provide information which the manager has to supply to someone else (usually his superior or the government). A significant part of the job of most managers is to organize, plan and control the use of resources (men, materials, machines, money) for the activities needed to produce a service or product. Figure I illustrates the use of information in a typical feedback loop used to control an activity. Monitoring includes recording information about the activity, comparing the actual with the planned result and evaluating the difference. This must be followed by a decision about what to do next, which returns the cycle to planning again. Thus it can be understood that, irrespective of the function carried out by the manager, information is required to monitor any activity which is controlled by him.

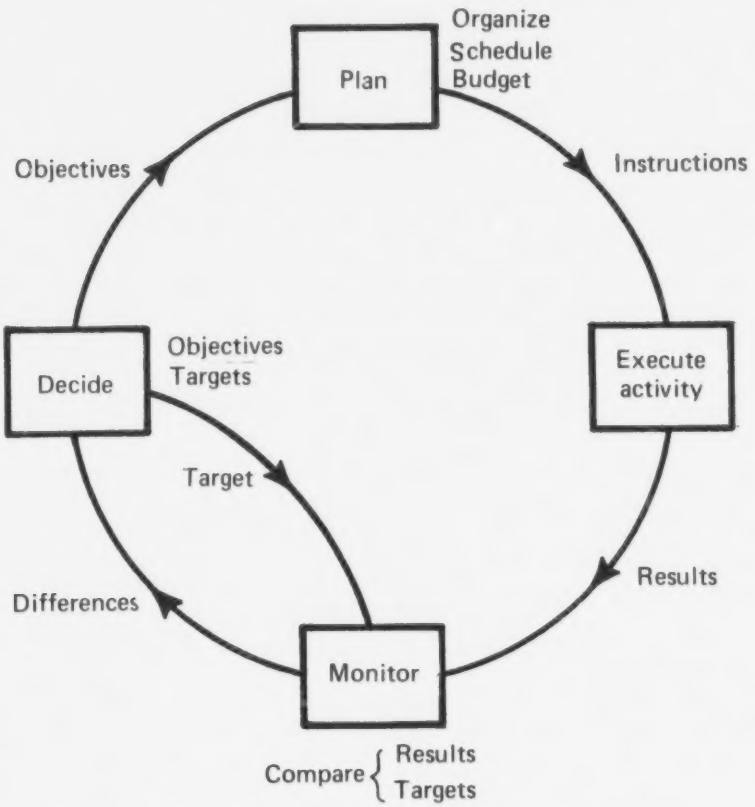
16. In fact an information system is required to provide the information required to control the activity for which the manager is responsible. This information system must be designed to provide the information required both to control the activity and to control the information system itself. Some examples of typical information systems are as follows:

- To plan operations on a container berth the manager needs information about the numbers and types of boxes to be loaded and discharged from each vessel. This information may arrive from a number of sources including telex and the manager must have a system to collate, organize and present the information to him in a useful way so that discharge and loading operations on the ship and in the container park can be planned.

- A stores-manager needs a system to provide regular information about level-of-stock, rate of use, etc., to decide the optimum economic ordering quantity and when to dispose of obsolete stock.

- To monitor expenditure, a manager requires a system to provide information about actual and budgeted expenditure for various accounting lines and the variance between them.

Figure 1
The flow of information in a feedback loop used to control an activity



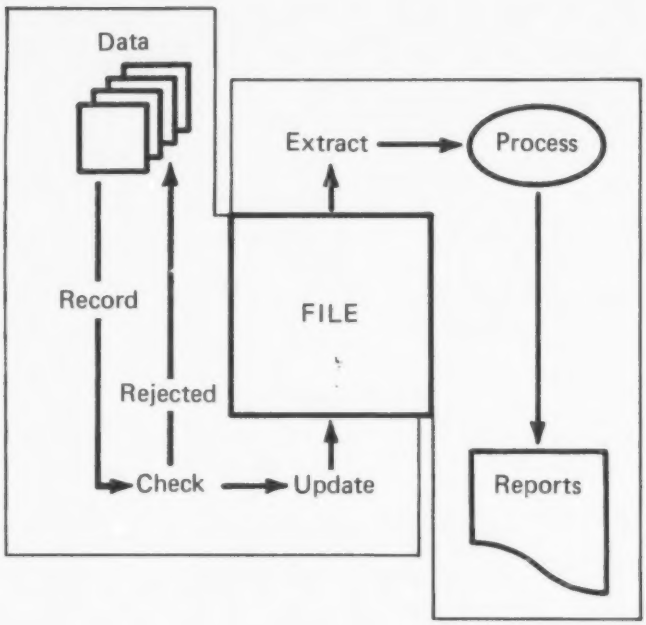
17. Most managers have to control several kinds of activity. A separate information system is usually associated with each activity for which the manager is responsible. The simplest requirement is for information which can be used to compare the actual situation with a plan. Information is also required for planning and for organizing, for example to know if the existing organisation is overloaded or if work can be eliminated. Managers often need information about their clients and they need information for preparing reports to their superiors. Thus managers must plan and control information systems which supply their needs for information. It seems to be the case in most organisations that the installation of computers as part of information systems has caused managers to review critically their existing information systems. Often this reveals factors which had previously been overlooked and sometimes changes the purpose of the information system as well as changing its form.

B. Structure of information systems

18. Many information systems can be divided into two overlapping subsystems as shown in figure 2. The first subsystem checks the information entering the system and then uses the validated information to keep a file up-to-date. Invalid information is rejected for correction and subsequent re-entry. The second subsystem extracts information from the file, edits it and produces reports. Of course information systems can be more complex, involving several files and the transmission of information between various subsystems, but many useful information systems are based on this pattern of two overlapping subsystems.

Figure 2

Structure of many information systems



19. In many systems, incoming information must be classified to allow analysis. The kinds of analysis which can be made depend on the ways in which the incoming information is classified. Information systems, like anything else are subject to error (mainly human) and so must incorporate control information so that the information processing can itself be controlled. Once inside the system, information has to be processed.

20. Figure 3 outlines an information system used by a manager to control an activity. Information in the system is subjected to various processes. As an illustration we can consider a simple stock-control system to maintain safe minimum levels of stock of all the various items in the stores. Information enters the system as records of stock issues and receipts of new stock. A stock-file is maintained. Orders are produced when the stock of an item falls below the re-order level. A report is produced (among others) every month showing the position of each item. The stores manager uses this report to adjust the re-order levels as required.

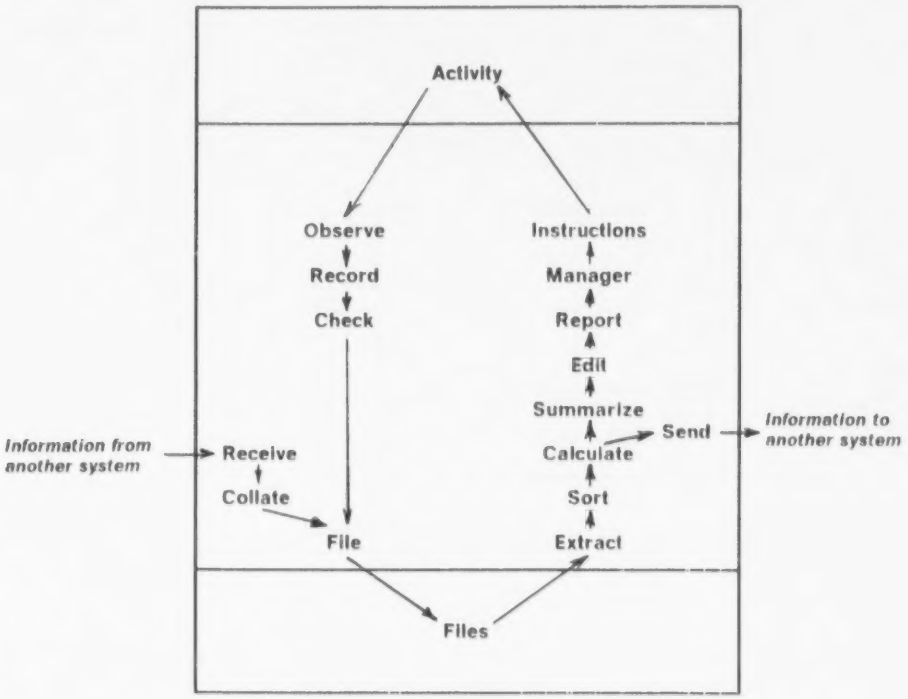
21. In such a stock-control system the information is subjected to a number of processes, viz:

recording	issues and receipts;
sending	issue and receipt notes from the stores to the office which does the ordering and reporting;
checking	plausibility of recorded information;
control	number of records sent from the store to the office;
sorting	issue and receipt notes into sequence by type;
retrieving	records from the file;
calculating	new stock levels;
updating records	after issues or receipts;
comparing	stock level with reorder level;
deleting records	discontinued materials;
adding records	new materials;
summarising	total monthly issues;
editing	putting the information in a suitable form;
reporting	to the manager.

The processes listed have been performed by clerks for thousands of years. All information systems can be analysed into these kinds of elementary operation.

Figure 3

Information Processing System to Assist a Manager to Control an Activity



C. Evolution of information systems

22. Information systems should report information at the right time, in the right place and in a usable form. The information should be complete and accurate and, if it is confidential, it should be secure from unauthorized access. Business is dynamic, organizations grow and shrink, circumstances change, managers change, governments' requirements change, techniques and technology change. For all these reasons, needs for information change. Sometimes information systems change to meet new needs but sometimes they continue as before, producing irrelevant and/or redundant information. This is wasteful and should be checked.

23. If a manual information system becomes overloaded things will start to go wrong. Information may be misfiled by staff working under pressure; reports are late and inaccurate. The system gradually degenerates because it contains an increasing volume of inaccurate, inaccessible and redundant information all of which has to be searched through to retrieve what is required. Those employed in the information system often resist change, for this reason the installation of a computer is sometimes taken as an opportunity to change or discontinue old information systems.

D. Reviewing information systems

24. Information systems should be reviewed regularly for all the reasons mentioned in section C on the evolution of information systems. Before considering the installation of a computer a manager should review his existing information systems. The first thing required for reviewing an information system is a very clear statement of the purposes of the system and the benefits of having it.

25. The following list of questions can be used to review an information system. But before doing so, write down the objectives of the system, either in terms of controlling an activity or in terms of supplying information for some other purpose.

- Is the information reported by the system apt for its purpose?
- Can it be obtained in any other way?
- Should there be more? or less?

- Is the cost of the information less than the benefits of having it?
- Is it presented in the most useful form?
- Does it arrive in time?
- Is it up-to-date?
- Is it complete?
- Is it reliable?
- Is it accurate?
- Is the observation and recording of the information satisfactory?
- Is the data properly checked?
- Could the information be obtained from another source?
- Is the information properly filed?
- Are the files up-to-date? complete?
- Is everything in the right place?
- Is the file organised in the best sequence?
- Can the most valuable/most voluminous/most frequently required information be extracted easily?
- Is information that is no longer required being removed from the file?
- Can the method of calculation (if any) be improved?
- Are there adequate controls on the system to ensure that all the information is collected, checked, classified, filed and reported as required?
- Is the information secured against physical loss (fire, flood, theft)?
- Is the information secured against unauthorized access?
- If information is received/transmitted by the system are there adequate controls to ensure no loss or corruption of the information?
- Is there an up-to-date users manual for the system?
- Is it adequate as a training aid?

E. Computers in information systems

26. When a computer is employed in an information system it is used to read, process, store, print, display and perhaps to transmit and receive information. Normally in ports the information to be processed is supplied to the computer by people and the results are acted upon by people. People also supervise the operation of the computer. Thus we can refer to the human-part and the computer-part of the information system. Both parts of the information system are vital for its proper functioning.

27. With the current developments in the electronic interchange of trade information, computers will become an essential link for data transmission and receipt. An internationally recognised standard for the electronic data interchange (EDI) of information is being developed and is known as the United Nations Rules for Electronic Data Interchange For Administration, Commerce and Transport (UN/EDIFACT). An International Forwarding and Transport Message (IFTM) is under development and will be a multi-use, multimodal message framework which will serve as cargo booking, cargo confirmation, shipment instruction, waybill and arrival notice message. It will also form the basis for a manifest message which is currently under development.

28. Rapid and accurate communications are becoming exceedingly important for multinational companies, international transport firms and also port organisations. Many ports are basing their EDI systems on EDIFACT. If all required messages are not officially sanctioned, proprietary messages should be based on the EDIFACT syntax, data dictionary and segment directory. This will facilitate the switch over to standard messages when they are approved. Paperless transactions based on internationally recognized standards will change the way international business is conducted and will affect all those involved in international trade.

F. Advantages of computers in information systems

29. The ability of a computer based information system to speed up the throughput of information and handle greater volumes of data than a manual system whilst being controlled by less staff is a major reason quoted for considering the use of computers. Reduced staffing costs and the potential for lowering resource costs in the form of rooms, furniture and consumable items may be substantial. Increased productivity implies a greater capacity to handle any growth in in-

formation processing that occurs as a result of business growth and an ability to provide a better service to clients.

30. Well designed computerized information systems can produce reports faster than the manual systems that they replace. Not only can the information be processed faster but also where information has to be brought together from independent sources the editing, retyping, redrawing, collating and reproduction of the final document may also be accomplished rapidly. A further benefit is the ability to respond rapidly to changes demanded of regularly produced documents, and to be able to generate new reports on demand. Generation of reports on demand, perhaps for viewing on a screen may avoid the necessity to stock a printed inventory of various reports, thereby saving costs.

31. Computers can very rapidly make comprehensive checks on information supplied to them and once corrected, errors do not reappear again. The ability to reproduce information accurately is a basic characteristic of computer systems. Spelling mistakes and numeric errors, for example, once identified and corrected cannot then reappear in subsequent documents. Computerization of data input and processing will do away with practically all the intermediate calculations and manual production of tables. Collection of information for operational needs can then be used for statistical purposes if care has been taken at data collection time.

32. The use of centralized computer files automatically assures consistency of information within the organization. Thus each department will use the same information source for answering queries, preparing invoices, making decisions and preparing statistics. Performance analysis will be based on data entered at the operational level thus avoiding interpretation and adjustment by the various intermediate departments that can occur with a manual system.

33. Accessibility to relevant information at the right time is a major benefit that is possible using a computer in an information system. In manual systems with conventional methods of filing and updating it is often impossible to state on demand, for example, the level of stocks, the total expenditure to date on a particular budget item or the last month's revenue from a particular service. This kind of information can be provided by a well designed computer system without additional clerical effort. The benefit is better planning and control, with managers having to spend less time searching for answers to relevant questions and having more facts available to support the decision making process.

34. The use of computers within an organization often demonstrates a modern and efficient approach to information processing. This indirect benefit may accompany more direct benefits. Higher quality documents often result from computer-based information systems and this also can contribute to an improved corporate image. Any reduction in boring repetitive tasks is usually welcomed by staff and, if it is accompanied by new tasks, the use of computing equipment can result in improved job satisfaction.

II. Developments in computers

A. General considerations

35. The range of equipment available goes from hand-held battery-powered microcomputers, through laptop microcomputers, desktop microcomputers, minicomputers to large mainframe computers. Each class of computer has rapidly become faster and of larger capacity and at the same time the cost has been reduced to the point at which a useful microcomputer, with printer, can be bought for a couple of thousand dollars.

36. Apart from cost and power (capacity to process large quantities of data very fast), the visible differences are physical size, and requirements for cooling and dust-free rooms. The mainframe and some minicomputers need specially air conditioned rooms, while many minis and all microcomputers can be used in normal office environments (although precautions may be needed to ensure a "clean" power supply).

37. Computer equipment has become more reliable, to the point where a microcomputer may run for several years with only limited maintenance. The larger computers may require more maintenance but the amount of maintenance required is becoming less and less. Mini and mainframe computers, and in some cases micros, can all accommodate a number of users, doing different tasks at the same time. All types of computers can be connected into a network to send to or receive information from other systems.

38. Today, mainframes are used for large-scale integrated business systems which store and process information for the whole organization. Minicomputers do the same thing on a slightly smaller scale. Micros are used more often for individual applications but they nowadays have sufficient capacity to run many of the information systems required for a firm with a limited volume of transactions to process. Microcomputer hardware is not only inexpensive but, perhaps more important, the software is inexpensive, abundant and often easier to use than for other kinds of computer.

B. Hardware

39. Hardware, is the name given to the physical parts of the computer such as the microprocessor unit, disk drives, keyboard, screen and printer. A terminal usually consists of a keyboard and a screen. Some screens are capable of displaying graphs, charts and even pictures in both black-and-white and colour. If the appropriate software is available then several documents/pictures can be superimposed on the screen at the same time and independently manipulated. The keyboard is used for entering information into the system.

40. Where high volumes of data have to be entered in batches - usually on mainframe machines, other ways of entering data rather than directly by a keyboard are often used. Information for input may first be recorded by dedicated data entry systems onto magnetic tape or magnetic disk and then read by the computer. These methods, in effect, interpose an intermediate medium between the computer and the keyboard which is more cost effective for data entry. There are also devices such as optical character readers and scanners which will read data directly from documents into a computer. Most of the problems of data entry are being resolved through the extensive use of on-line data processing techniques where data is entered as it is generated and not collected in batches for subsequent processing.

41. Dot-matrix printers print in a variety of type styles and type sizes. They can also print graphics. Laser printers use technology similar to a copier and can print documents, including pictures, of quality similar to a professional printer. Where very large volumes of printed output are required, line-printers attached to mini or mainframe computers can print several thousand lines per minute.

42. Disk drives are used to store the files of information in the computer system. The type of drive determines the capacity of the system and the speed of access to the information. These two factors affect the speed of processing of information and are important considerations when buying computer equipment. Storage capacities are expressed in *K*ilo - thousands, *M*ega - millions, and *G*iga - billions of *b*ytes, where 1 byte can be assumed as one character (letter or number). As an example, an ordinary PC may have removable floppy diskette drives with a capacity of more than 1 Mb and a faster fixed disk drive with a capacity from 20 Mb to more than 100 Mb. Minis can

be equipped with fast disk drive capacity from a few hundred Mb up to a few Gb. The cost of both kinds of disk-drive continues to lessen and the capacity continues to increase.

C. Software

43. Computers require sets of instructions to process information. These sets of instruction are called programs and software is another name for programs. Software can be roughly divided into three areas - ***systems software*** (programming languages, operating systems, networking packages, sophisticated database packages and other development tools to be used by professional programmers), ***general purpose packages*** (word processors, spread sheets, simple database packages, etc.) and ***application systems*** (stock control, personnel, invoicing, etc.). Software is the critical component in the system: it determines the security, cost and the ease with which the system can be changed to conform with changing circumstances and the ease of using and operating the system.

44. One important program which every computer must have is the *operating system*. This software provides the interface between the hardware and the application software. Applications software written to be used with one operating system cannot usually be used with another operating system without modification and sometimes not even with earlier versions of the same operating system. For this reason changing computers and operating systems usually requires changes in the application program. The choice of operating systems is very restricted. They are almost always supplied by the manufacturer of the hardware. There is growing pressure on manufacturers of hardware and operating systems to assure the possibilty of the transfer of application software between different computers.

45. For microcomputers compatible with the IBM PC range there is the *de facto* standard operating system MS/DOS and derivatives of the Unix operating system. With mini and mainframe computers the operating system is usually supplied by the manufacturer. Unix is also available in some cases and there are a growing number of users. The operating system imposes standards on files including the format in which they are recorded on the disk. This determines the possibility of having one computer read disks written by another computer. Standard formats for files help to ensure compatibility between different data processing systems. If installations have the same operating systems, transfer of application software is in most cases very straight forward.

46. General purpose packages are a very flexible software option which are relatively simple to use and inexpensive. Because of their broad appeal there is very good software support and considerable expertise available. However, it does not make the most efficient use of the hardware and would normally require more storage capacity and processing power for a given system performance standard than a specialized application package. This consideration has become less important as equipment costs have fallen.

47. There are a number of well-known software packages of this type, they are generalized programs which the user can adapt to his own purposes. Mostly they carry out processes which are common to a large number of information processing systems, for example:

- word processing packages which can be used to prepare and print many kinds of document and significantly reducing the amount of retyping to be done;
- spreadsheet programs which can be used to create and manipulate large tables of any kind of numeric or alphabetic data and are used for a very wide range of purposes such as statistics, planning, economic and financial analysis;
- database packages used to generate software to enter, store and retrieve information from files, and to prepare and print reports;
- statistical programs which can be used to analyse data by a wide range of well-known statistical techniques.

48. Applications systems are a set of programs developed by professional staff for the specific needs of a particular information system, for example container tracking. Usually in these systems there are a number of users sharing the computer resources. All the users may work at the same time using the same or different functions (programs), and review or update common files. Such systems are developed based on more complex database packages and adding, when required, individual procedures in one of the programming languages to cope with particular requirements

referring to the control of input data or to perform special processing. When feasible, the whole system should be produced using standard database software as this gives significant savings in development time. This approach requires expert technical management to be successful. Nowadays there exists a wide range of software packages covering file maintenance, report generation, word processing, spread sheet processing, the networking of microcomputers and communications via telephone and telex. Contractors, as well as local staff are likely to use these packages to produce applications software because of the saving in time and improvement in reliability that they offer. There are advantages in choosing this approach to the acquisition of software because it allows rapid development of systems and rapid amendment when that is required.

III. Applications in ports

A. General considerations

49. This section describes some of the information systems in ports for which computers have been used. Installing a computerized system costs time, effort and money so the first thing is to be sure that some benefits will be received in return for the expenditure. Computers can be utilized at all levels of management in the port sector. Computers are being used in ports worldwide and not only in the developed countries. Many ports use computers for administrative purposes at present; indeed accounting, billing, accounts receivable, personnel management, and payroll have so far been the main area of use in ports. However there are a large number of operational areas suitable for computer applications: spare parts management, cargo and vessel control, operations planning, container operations, project planning, project monitoring, research, performance monitoring and equipment management. All forms of inventory control, including cargo control, usually produce substantial benefits from unsophisticated systems. A select list follows of some of the computerized systems that are running in ports and that have already proved their worth.

- container tracking;
- cargo control;
- billing for port services;
- accounts receivable;
- inventory control, for spare parts and general stores;
- payrolls;
- personnel records;
- revenue and expenditure accounting, cost accounting, capital accounting, management accounting;
- pre-arrival preparation of documents for ship discharge;
- analysis of hydrographic-survey data.

A description of a system used in the container terminal at the port of Gdynia, Poland, is given in annex I as an example of a practical and very common application for ports. A conceptional overview of a number of these applications is given in the following sections.

B. Container tracking

Outline Container tracking systems maintain information on the location and status of containers, either concurrently or retrospectively. This system may also be extended to plan the movement of containers and equipment using information entered into the system in advance. The usefulness of a container tracking system depends on the reliability of the information entered as well as on its being up-to-date. To plan container movements, the computer is used to assist in directing the operation of equipment and it may be used to determine the position where each container will be placed, both in the ship and in the container terminal stack.

Inputs The inputs are the details of containers arriving at and leaving the terminal both by land and sea and all movements within the terminal. Details of ship-stowage for arrivals and loading lists for departures plus information about the position of container berth equipment (cranes, straddle carriers, etc) whose movements may be controlled by the system are required for planning the loading and discharge operation. Much of the information input to the system may be transmitted by telephone, telex or other electronic means: other items will be entered via keyboard.

Outputs The primary output is the locations of containers which is used by staff to operate the terminal. There will also be statistical information about numbers, shipping line, type, size, contents, destinations, etc. If sufficient detail is entered then the system may be used to produce some of the documents required for the movement of the

containers, for example loading lists, discharge lists, discrepancy lists and customs forms. An extended system may produce movement instructions to individual crane drivers (perhaps via a screen in the cab) to speed up container movements.

Benefits The prime benefits are: faster turnround of ships and containers; greater productivity of space, equipment and manpower; better use of capital investment; reduced paper work. A container tracking system avoids delays due to problems in locating containers. Besides the operational information, additional information on equipment availability, maintenance schedules, service rendered to customers, billing, etc., can easily be obtained.

Costs A fully computerized container tracking system requires investment in data transmission and computer equipment. This investment will be a small fraction of the investment in the terminal and container handling equipment but nevertheless substantial. Retraining of staff will be necessary because the efficiency of the operation of the computer system and therefore of the container terminal operation will depend on the way in which the staff use it. There may be opposition to the computerisation from labour both because such systems displace human labour and because of the changes in working methods required to obtain the best from the system.

Integration This system can supply information to the billing, payroll and equipment management systems.

C. Cargo control

Outline Where substantial quantities of goods are left in transit sheds or on quays, a simple computer system can be helpful in keeping track of what is in the shed and where it is stored: the system can also keep details of ownership, date of arrival, dues payable etc. There is much to be said for using a dedicated microcomputer system, located on the spot, for the purpose.

Inputs The manifest may be used as a source of input for imports together with a record of the goods as they enter and leave the shed. The other details of the goods to be entered depend on what use is to be made of the system.

Outputs Using an on-line system the location of goods can be displayed on the screen as required. The system can print lists of goods to be inspected by customs and lists of goods remaining longer than a fixed period: dues can be calculated, release notes can be printed to give an accurate control of outgoing goods. The system can be used to analyse the throughput of the shed (and revenue) by owner and type of goods, to calculate dwell time or even give a breakdown of the type of transport required to move the goods to various destinations.

Benefits This type of system can be used to reduce congestion by showing the manager which goods are remaining an undue time in the shed and identifying the freight forwarder or consignee responsible for taking delivery of the goods.

Costs The effectiveness of such a system depends on the quality and completeness of the input data. Training the shed staff to use the system must therefore be thorough and some form of physical check on a sample basis must be instituted to ensure completeness.

Integration This system can supply information to the billing system.

D. Billing

Outline Depending on the responsibilities of the port authority it may have to produce invoices for a range of items from rentals for land/property through services to ships for stevedoring charges. The requirements may vary from, for example, invoicing monthly or quarterly for rentals to invoicing ship's masters for services before the ships departure (which may be within a few hours of the ships's arrival). This range of billing systems can all be computer based. The use of a computer for billing in

addition to producing accurate and timely invoices which improves the cash flow, also is often a valuable source of information which, in combination with cost information, can be use to control the business better.

Inputs Generally the inputs to the system will be details of the services rendered input by keyboard. Inputs can also come from cargo control and container tracking systems. In the case of long-term agreements for rentals these details may be entered only once after which the computer will produce periodic invoices on the due date. Details of tariffs and dues may be entered once at the start and thereafter only when they change.

Outputs The main outputs will be the invoices but, in addition, an analysis of revenue can be obtained by user, by type of cargo, etc..

Benefits The main benefits are speed and accuracy in producing invoices, the possibility to obtain revenue analysis easily and the by-product information which can be used in the accounting system without having to re-enter it by hand.

Costs Apart from the cost of data-entry and computer costs some time and effort must be spent on the control of the system - to ensure that all the information is entered on time and that errors are corrected as they are found by the system.

Integration The details of the invoices can be passed to an accounts receivable ledger: the details from ship and cargo dues can be used to produce statistics often of interest to the government if they have no other way of obtaining them.

E. Accounts receivable

Outline The prompt receipt of payments due for services rendered is one of the critical factors which affects the financial health of any business. Control of outstanding debt is essential to avoid unnecessary losses. Where bills remain unpaid it is essential to know, so that statements can be sent to remind customers that their payment is overdue.

Inputs The system will receive information from the billing system on all the invoices issued and details of all payments received will be input by keyboard.

Outputs The system produces account statements and other reminders for all customers who have not paid invoices by the due date. The system will also produce various analyses of the debt owed to the company: for example by age of debt, by customer and by size of debt. The system may also be used to control credit: reference to the file may be made before services are supplied to ensure that previously supplied services were paid for.

Benefits The use of such a system should improve cash flow and help to avoid bad debts by controlling credit. The use of a computer in the system makes the information more readily available and facilitates the frequent production of statements and analyses.

Costs The main costs are the computer costs and the cost of entering the input. Where part payment of invoices is received the allocation of payment to the invoices may require some care. All systems which deal with the preparation of invoices and the receipt of payments have a risk of fraud and controls should be designed carefully to reduce this risk.

Integration The input for the system may be obtained at little cost from a billing system and from the cash control system if they are computerized. As noted above the outputs of the system may be used for credit control.

F. Inventory control

Outline Stocks of spares and consumable items are essential to the smooth operation of a port. The cost of purchase and storage of these items is often considerable and this

cost can usually be reduced significantly by using an appropriate inventory control system. A simple inventory control system would record the issue and receipt of each item in the stores. This information would be used to maintain up-to-date an inventory file, which, in addition to showing the quantity of each item in stock, might also record the date of last issue, a reorder level and the purchase price for each item.

Inputs Typically, the storeman would record each issue and receipt of stock either on a form or directly on a computer terminal. The stores-manager or an accounts clerk would record reorder levels and the cost of purchase of each item.

Outputs From such a file, reports can be produced showing, for example: items out of stock, items to be reordered, value of the stock, items not issued in the last 12 months, the quantity and value of every item issued in the last six months.

Benefits This kind of information can be used to control the level and purchase of stock items to minimize the risk of being out-of-stock and the holding cost. Stock which has not been used in a long time may be sold, thus releasing working capital and space. When the file updating and report-production are done by computer, it is much easier to apply many more checks to the inputs than would be possible in a manual system. It is much easier to produce up-to-date reports and more sophisticated analyses to improve control of inventory. In a medium to large port the installation of an inventory control system might be expected to lead to savings of the order of $10,000 per annum.

Costs To obtain the full benefits of an inventory control system the manager must be trained to use the information provided by the system. The staff must be encouraged to be accurate and regular stock-taking is desirable to correct the inevitable discrepancies between the actual physical stock and the stock recorded in the file. This stock check may be controlled by the computer system.

Integration The inventory control system may be integrated with the accounting system to which it may supply:

- purchase orders for the purchasing system;
- cost-of-materials per job to the job-costing system;
- accounting information for periodic accounting statements.

G. Payroll

Outline Very often several different payrolls, for different types of employee, may be required in a port. In all cases the system will produce pay slips at the appropriate intervals (weekly, monthly) but for those on some form of piecework the input information will be more voluminous and the processing will be more complex. Depending on local circumstances the payroll system will make deductions (including tax) and may produce by-product information for job-costing and other accounting purposes and possibly for a personnel records system.

Inputs The main inputs to the system will be changes to the employee's details held in the system and details of work done where pay and/or job costs depend on it. The control and timely correction of all this information is quite a demanding job and is essential to the running of the system.

Outputs The payroll system is normally in part at least a batch system and usually has to produce a large quantity of printed output, mainly pay slips, in a short time. For this adequate printing equipment is needed. The system can produce summaries and returns required for accounting purposes, control of tax and other deductions.

Benefits The main benefits of a payroll system are a reduction in the clerical labour required and the possibility to capture information required by other systems (accounting and personnel) which have larger potential benefits.

Costs The main cost of operating a payroll system is in collecting and keying in the input. Careful control must also be exercised to ensure that input is correct and complete.

Integration The payroll system can produce useful information which can be input directly to the accounting and personnel systems.

H. Personnel records

Outline In a port where a large number of personnel are employed it is a tedious job to maintain the personal records manually, which may contain information about qualifications, pay, history of previous posts held, training, etc. Such details do not change very rapidly and, once entered, they can be used for all sorts of analyses, for example to find all employees with certain qualifications.

Inputs Details of employee's qualifications, training, posts held, salary, etc. Pay details, when they change, can often be obtained without manual input from a computerized payroll system.

Outputs Analyses of the workforce by age, salary, qualification, department, etc.. Searches to find employees who have particular combinations of qualifications and/or experience.

Benefits The rapid identification of employees who match certain requirements and the easy production of analyses required for human resource development.

Costs The initial cost of creating the employee file may be considerable if the workforce is large. The maintenance to keep the file up-to-date afterwards is usually not a large job.

Integration As already noted, it may be possible to obtain the information required to keep the salary details up-to-date from the payroll system if that is computerized.

I. Accounting

Outline Accounting systems vary according to local legal requirements and the nature of the port's business. Normally periodic accounts must be prepared and these may include statements of account for various classes of operating activity (for example, berth operation, services to ships) and for various classes of trade as well as maintenance and other job costs. Capital expenditure projects may also be accounted separately. A computer system may be used to keep all the ledgers required or the computer may deal only with part of the accounting transactions from which it will produce intermediate statements which would be used to prepare full accounts manually.

Inputs The accounting transactions required may be input directly via a keyboard or they may be obtained as information from other computerized systems, for example, stores, payroll, and accounts payable for costs and billing and accounts receivable for the receipts. A well thought out system of classification and coding of transactions is required if an integrated accounting system is to be effective.

Outputs The corresponding accounting requirements vary greatly between ports. The small sample list of outputs given next is thus only indicative:

- ledgers for expenditure, receipts, and capital works;
- statements of costs and receipts for major classes of operational activity;
- maintenance job costing, workshop job costing;
- profit-centre ledgers and accounts;
- profit and loss accounts;
- revenue accounts.

Benefits The benefits to be derived from a computerized accounting system are mainly speed and range. Thus for example end-of-period accounts are available earlier than with a manual system, are more up-to-date and hence more valuable for the control of the

enterprise. Once information is in the system, the range of reports and analyses that can be prepared quickly is greatly extended; and the information can easily be analysed in ways which would have been difficult in a manual system.

Costs Apart from the cost of data-entry and computer costs, some time and effort must be spent on the control of accounting systems - to ensure that all the information is entered on time and that errors are corrected as they are found by the system. It is also particularly important that the manager responsible establishes and enforces security measures to ensure that the system can recover from natural and other disasters, such as fire, flood, theft, breakdown and destruction of magnetic media.

Integration The possibilities for integration with other computerized systems lie mainly in the use of data already stored in other systems: it may be necessary to review the controls over the input of information in the other systems to ensure that the quality of the data received is adequate for the accounting system.

IV. Acquiring a computerized information system

A. General considerations

50. The computerization of any of the sytems mentioned in the list in the previous section is, generally, feasible. However, in particular circumstances, there may be difficulties for the applications listed above which will lie outside the computer system. For example, one might not be able to collect all the information required or not quickly enough to make the computerized system worthwhile. Environmental conditions such as a lack of maintenance or an unreliable power supply may also make a computerized system impractical. Also there might be local difficulties in operating the system because of labour agreements.

51. The first step is to determine the requirements and to decide upon the probable costs and benefits of the proposed application. Once the costs and benefits of a potential application have been determined, a sensible decision can be made about whether to proceed. Before making a decision for each application, two or more alternative information systems should be evaluated, for example:

- keep the existing system as it is;
- improve the existing system (purchase of calculators or a better filing system, hire more staff, etc.);
- replace the existing system with a computer system.

This evaluation will allow the management to decide whether to proceed or not.

52. The manager contemplating the use of a computer in one or more of the port information systems may find that:

- a mainframe or minicomputer is already being used in some of the local port information systems;
- one or more microcomputers are being used in local port information systems;
- no computer is being used in local port information systems.

53. The procedure for acquiring a computerized information system varies in detail depending upon which of these three possibilities exist, but the general principles remain the same. If computers are already being used locally, then there should be local experience available, otherwise advice should be sought from an expert. The same procedure can be used to change an existing information system. The procedure varies somewhat with the size and complexity of the information system or the size of the change contemplated. Obviously one will not go through a complex procedure just to change the layout of a report already being produced nor for the implementation of general purpose packages such as word processing, spreadsheets, etc.

54. It is probable that the manager will employ specialists to do most of the work. Good communications between the manager and the specialists are crucial to the effective development of a computerized information system. However, the manager has certain responsibilities which cannot be delegated to the specialist. The manager has final responsibility for the approval and acceptance of the system. He and his staff must devote adequate time to all the steps of the procedure, from the initial definition of requirements to the installation of the system.

55. This report does not discuss the management of systems analysts and programmers, which is a specialized topic. However, it is extremely important that the relation between the manager and the specialists should be a relation of customer to supplier, even if the specialist works in the same organization.

B. Outline

56. The work of acquiring a computerized information system can be divided into manageable steps. Discipline is essential in acquiring a computerized information system. The alternative is, at best, cost and time overruns and at worst a complete failure, with adverse consequences for the

business. At the same time the formal requirements are best kept to a practical minimum, because the manager can insist that all are completed properly.

57. The main steps for the manager are:

- define requirements;*
- accept a specification of the system;*
- select supplier for software and hardware;
- accept a Users Manual;*
- test the system;
- train the staff to operate the system;
- install the system.

58. The steps marked with an asterisk produce a document which the manager must consider carefully. The quality of the documents involved in the development and implementation of a computerized information system is important. They must be relevant, specific and brief but complete and written in non-technical terms. These documents produced are of paramount importance to the manager.

59. The manager can control the development by assuring that each development phase has been completed successfully before starting the next one. Estimates of the cost of developing the system - either at the definition of requirements stage or, at the latest, at the system specification stage - should be obtained before starting and a decision taken to continue or stop if costs exceed the expected benefits. The selection of suppliers for hardware and software may not be required if the new system can use existing equipment and software packages.

C. Statement of requirements

60. If a port manager was considering the installation of a large-scale system in terms of investment, then it would be sensible to make a survey of all the information systems which would benefit from computerization in his particular circumstances. Usually these systems are those with a large number of users, a large area of coverage (for example, at the corporate or divisional level) and/or a large volume of data to be entered and processed. As a result of the survey, for which a systems analyst would be employed, a list of systems for computerization would be prepared and the costs and benefits of each system evaluated. This would allow the rationalization of investment for computer hardware and the integration of the various systems. At the other extreme, for small applications, the manager may have identified an information system in his own department which might benefit from the use of a microcomputer. In any case the investment for a microcomputer is small and provided standards are defined and followed for equipment procurement, the system can be eventually integrated into a larger system.

61. After identifying an area or function for computerization, a statement of requirements must be written. The purpose of this statement is, first, to clarify in the mind of the manager what it is that he wants and, secondly, to convey these requirements as unambiguously as possible to the person who will develop the new or revised information system.

62. The manager must play a leading role in the preparation of the statement of requirements. Ideally he will prepare the statement himself or, depending on the scale of the problem and particular conditions, he may employ analysts to collect and analyse information to assist him in taking his decisions. When larger systems, for example at the corporate or divisional level, are considered, steering committees made up of the managers concerned and under the chairmanship of the director involved can be created to manage all aspects of development and implementation.

63. One of the most frequent and disastrous mistakes is that the manager does not take sufficient care over the statement of requirements, resulting in the production of a system which is not what the manager needed. Above all, the statement of requirements should be written in non-technical language. It is a statement of what the system should do, expressed in terms appropriate to the human part of the system to be controlled. In this way the manager can be clear that his requirements are properly expressed. Technical considerations should not appear at this stage except

perhaps in the form of statements that both the software and hardware must be compatible with that already existing or with certain standards.

64. For a manager with little or no experience of using computers, the preparation of a statement of requirements for a computerized information system might seem to be rather a daunting task. Whatever he does, he must not delegate this task to others, as it is a statement of his requirements for information, not a technical description of the system. ***The manager must refuse to be overawed by jargon and work on the principle that the technical people must explain things in non-technical language.***

65. The manager's statement of requirements should not, however, be regarded as immutable. A specialist or consultant, after considering the statement of requirements and possibly some investigation, may return to the manager with a suggestion for a revision which would then be discussed and considered and might lead to a change. The grounds for such a revision might be, for example, significant additional benefits which could be obtained, or difficulties and costs which might be eliminated by changing the boundaries of the system.

66. Of course the statement of requirements may be very simple, for example, when a new report is required from an existing system. Even in this case where it may be adequate to tell the technician what is wanted, it may be preferable to write it down because information systems are usually more complex than they appear and misunderstandings can easily arise. In the case of a new system for which hardware and/or software must be purchased, the statement of requirements should cover all the items in the list which follows.

67. Before considering in detail the preparation of a statement of requirements for an information system, it is worth emphasizing that these are primarily requirements for the information system, not for hardware or software at this stage, although of course those needs are determined from the requirements.

68. This statement should contain the following items in the case of a new system, but less in the case of amendments to an existing system:

Objectives A statement of the goals to be achieved and the expected benefits quantified in whatever terms are appropriate to the particular application and local circumstances. Examples of goals might be:

- more complete, accurate and timely information;
- better control over the information system;
- maintain market share, for example, you are losing traffic to competitors who are able to handle cargo faster because they are using computers;
- meet new requirements which cannot be dealt with by the existing system (for example, government statistics);
- provision of monthly management accounts one week after the end of the month;
- producing bills for ship's services before the vessel sails

The benefits of the proposed system must be evaluated in quantifiable terms to obtain approval for the necessary expenditure. Examples of some of the benefits that can be obtained from the use of computerized information systems are as follows:

- reduction in outstanding debt by 30 per cent;
- reduction in average stock outages to less than one a month;
- better service to customers resulting in increased traffic.
- reduction of cost of producing information.

Some of benefits are quite difficult to quantify because, without a computer system, the information required to evaluate the benefit is not available. Some benefits, such as the "modern" image created by use of computers, are less tangible but nevertheless real and valuable.

Scope The information to be processed by the system, who will be involved in the operation and use of the system, an indication of the boundaries and the limits of the system, together with a description of the general functions of the system. This section would indicate the number and type of users involved, the area of coverage, number of transactions to be processed and the processing to be done. For example, the invoicing system will produce invoices only for dues and not for cargo handling; the system will check the input and calculate the cargo dues based on the type of cargo and the metric tonnage and the system will produce 500 invoices daily.

Outputs Characteristics of the basic information to be produced from the system. In describing the contents of the reports produced it is not necessary, at this stage, to enter into details of the exact layout of reports.

Inputs Characteristics of data to be collected for computer processing. It is worthwhile, even at this stage, to give some consideration to the practicality of providing the information required for processing in the system and how to ensure its accuracy and timeliness.

Controls State what level of control and security should be provided over the operation of the information system - for example, data are to be accessed only by a limited number of staff and files are to be kept for 5 years.

Standards State whether the system is to conform to either internal, national or international standards - for example, the use of national spare parts codes, international port codes, standard layouts for forms and hardware/software standards for the exchange of information.

Limitations State what financial, technical and organizational restraints or special requirements must be considered for the development and operation of the information system - for example, system must be developed in six months, system must allow exchange of information with other port users, system must work for 24 hours and maximum downtime allowed one shift.

69. Controls and standards, because of their importance for the development and operation of information systems, are discussed further in annex II. None of the items in this statement need be over-elaborated but it is worthwhile to take trouble over it. One should consider carefully what is essential for the system - prune out all the unessentials, if possible specify exception reporting (the printing of only those records meeting specified criteria) to avoid wading through enormous piles of printout looking for the few records of real interest; collect only enough data to provide the information required plus sufficient additional data to check that one has all the data and that they are accurate.

E. System specification

70. The system specification is produced from the statement of requirements and from additional investigation by an analyst or consultant. One should make sure that the analyst understands that the system specification required is a specification of the data and information in the system and of the controls and the timing, and not just of the hardware or software.

71. The system specification, which will describe exactly what the system will do, should:

- describe the objectives and benefits of the system;
- describe the organizational structure and flow of information for the system;
- describe each facility to be provided by the system, how it is to be used, what errors will be detected, how they will be corrected;
- describe the reports exactly, when they will be produced, who uses them, what for, contents outline, volume, frequency;
- describe the input data exactly and how they are to be collected (what, when, how much, where from, who provides it);
- describe exactly the data in any files which will be maintained by the system;

- describe the controls over the operation of the system for input, processing and output, who will use them and how they ensure the integrity of the system;
- describe the security and recovery procedures for the system;
- describe the hardware and software requirements;
- estimate the time and cost for developing and operating the system, for example:
  - purchase of computer and telecommunication equipment;
  - preparation of suitable accommodation (air conditioned, clean environment, reliable power supply);
  - purchase and/or development of software;
  - cost of training port staff to use the new computer systems;
  - management and staff costs to run the computer section;
  - data transmission costs, if any;
  - maintenance of equipment;
  - supplies of paper, magnetic tapes and disks.

72. The system specification must be reviewed carefully to decide:

- that the system specified does meet the needs specified in the statement of requirements;
- that the manager can arrange for the provision of all the input data required to operate the system;
- that the controls will guarantee the correct working and security of the system;
- that the system is within the financial, technical and organizational restraints as specified in the statement of requirements.

F. Users manual

73. The Users Manual supersedes the system specification and is the only document that the user need keep up to date. It may differ from the original system specification because of changes made during implementation or after use of the system. The Users Manual describes all the facilities provided by the system and how to use them. It also describes how to carry out each task involved in the running of the system and must be complete enough to be the only source of reference needed by the user's staff to solve any problems that may occur during the operation of the system. Technical staff may require other documents, for example program listings and operating instuctions, but these are not considered here.

74. The manual should also serve to train staff to operate the system. It must therefore contain all the information required to operate the system and it must be written so that it is clear and easy to use, with an adequate index, and replaceable annexes for those parts which will change (for example, schedules and codes). The Users Manual is the only firm basis upon which to judge the adequacy of the proposed test for the system. In summary, a good Users Manual will make life bearable but a bad one will at best waste time and may lead to unintentional loss or corruption of information.

75. When software packages are being used in the information system there will normally be a manual which describes the package. This manual, by itself, is not usually adequate as a Users Manual because it describes only the computer software. Even in the case of a word-processing package there will usually be additional *house* standards for the layout of letters, memoranda and other documents.

76. This manual should contain all the information required to operate the information system. It should be quite specific, well indexed and as brief as is consistent with completeness. It is a tool for those who have to work with the system and should contain all the following items:

- table of contents;
- outline of the system describing briefly the purpose, scope, functions and listing the facilities provided by the system and describing the flow of information in the system (a diagram may be helpful);

- for each type of input, source, volume, frequency, purpose, precise description of the input form or screen with an annotated sample;
- for each type of output, user, volume, frequency, purpose, brief description with annotated realistic samples stating the derivation of each kind of item reported (totals, sub-totals, calculated values);
- for each facility offered by the system, a full description of how to use it, stating how errors are shown and corrected;
- a statement of the controls over the operation of the system provided to the user, how the controls should be operated;
- a description of the measures required to ensure security against loss of information from the system covering at least procedures for the control of information in the files and recovery from loss or corruption of the information in the file(s);
- an up-to-date list of codes used in the system and a description of how to change them;
- an index.

77. The manual should describe how to use each facility which the system offers. Each form or screen must be described, stating its purpose, how to complete it and how it is checked by the system. The validation and updating processes must be described. The method of correcting each kind of error must be described. The manual should describe each report produced by the system, its layout, when it is produced, who uses it, its purpose, the information it contains and the derivation of all the quantities printed in it. Finally the manual must describe the registers and other controls used in the system and the procedures which should be followed to maintain security of the files, including recovery procedures.

G. Purchasing computer hardware and software

78. Perhaps the most important thing to remember is that these purchases should be treated just like the purchase of any other equipment. At all stages in the process of implementing a system formal relations must be maintained with suppliers, with formal meetings and recorded minutes. This is the only sure way of maintaining a diary of proceedings that may be lengthy and complex. If a project leader for the proposed system has not already been appointed prior to the evaluation stage, he or she should be designated and given a clear set of responsibilities, including the style of relationship to maintain with suppliers.

79. If new mainframe or minicomputer equipment is to be purchased, expert advice should be obtained. If microcomputer equipment is to be purchased, care should be taken to purchase standard equipment (at present *de facto* standards are the ones that apply). Beyond the equipment itself the most important considerations are the availability of a reliable power supply, a reliable maintenance service for both hardware and software and supplies of consumables like paper, printer ribbons and diskettes.

80. The choice of software is a technical matter. The manager should seek written assurances that the software proposed is adequate for the work described in the statement of requirements and system specification. Where the purchase of additional software is being proposed, compatibility with existing software and hardware is important. As the software is the most important part of the system other than the users, great care should be taken in its purchase and acceptance.

V. Implementing the computer based system

A. General considerations

81. This section deals with installing a new system or substantially changing an existing system, as well as with monitoring the operation of computer systems. Testing a system and training staff to operate it are also discussed. Both these activities are essential to the successful installation and operation of a new system, but they are often neglected by the manager responsible, sometimes with disastrous results. The following paragraphs explain how the manager may ensure that the testing is carried out thoroughly, what kind of training may be required and how it may be accomplished. The methods which apply to new systems apply equally well to systems which have been changed in a significant way, for example, by the addition of new forms of data entry and new reports.

82. Before being able to test a system properly one must know exactly what it is supposed to do. Similarly before being able to train people one must know what they have to do. All this information should be contained in the Users Manual for the system and so the first essential is to ensure that this document is complete. The manager should review the Users Manual carefully to ensure that the system it describes does what he wants it to do and that it will be easy for his staff to understand. Since this will be the reference book for the future operation of the system and the basis for the testing the system it is worthwhile to do this review thoroughly. Where the system is based on a software package, the manuals may be inadequate in some aspects. In that case a consultant may be employed to write a manual which suits the particular application for which the package is to be used. The manager is reminded that ***the whole system*** not just the computer part must work properly together if the benefits are to be obtained.

B. Testing

83. Before testing the whole system a test plan, test data and expected results should have been prepared and agreed with the manager responsible for accepting the system. The test is normally divided into parts: each part being devoted to testing specific aspects of the system, usually progressing from the straightforward to the more complex aspects of the system. Systems should be tested to demonstrate that they work as expected and to ensure that they do not accept nonsense, either as data or commands. All the facilities that will be used should be tested. Besides using typical data it is important to test the system at its limits (maximum and minimum values that will be encountered in practice). A sample of the user's normal data is not recommended for testing a system because it neither spans the whole range of possibilities nor does it contain all the possible kinds of error.

84. When testing a computerized information system it is important to test the whole system, not just the computer part of it. It is wise to make sure, for example, that the information to be processed can be provided complete, accurate and on time and that any errors detected can easily be corrected by the operators using the facilities provided by the system. The following list summarizes what should be tested:

- data collection and recording procedures with a full range of information;
- each data entry form;
- each type of report in sufficient length to test page and screen changes, sub-totals, etc.;
- each separate error which the system should detect;
- each kind of file updating action;
- the file recovery and security procedures.

85. Before testing begins arrangements should be made to record all the errors found during the tests so that nothing is overlooked and a proper analysis can be made. When it is thought that all errors have been eliminated from the system then it is most important that the complete set of tests should be repeated to demonstrate that the later corrections have not provoked problems with the parts of the system already tested. At this point the manager should personally check a small sample of the results chosen at random. The test data and results should be preserved so that if it becomes necessary in the future to alter the system it can afterwards be tested to show that no unexpected (and unwanted) alterations were made.

C. Training

86. The staff have to be trained to:

- use every facility in the system;
- operate the controls incorporated into the system;
- use the file recovery procedure;
- use the reports produced;
- fill in the forms/screens for data entry.

87. The fears expressed by some port organizations in developing countries about the capability of their staff to use computer systems are unfounded. A computerized system is often easier to use than a manual one as help screens are often available to provide assistance for entering data or requesting reports. However, initial training on how to use the system is essential. Training should commence when the hardware and most, if not all, of the tested software are available. The Users Manual is used as a basis for the training. A plan must be prepared and the most senior people trained first, who then train the rest of the staff. Staff who provide the data and, if necessary, the people who transport it must also be trained in order to understand the importance of timely delivery. The people who designed and produced the system normally will provide training. However if an application system or general-purpose package has been purchased, the port may have to do its own training using the Users Manual provided.

D. Installation

88. In some cases, before the system can be used a large file of data must be created and checked. This can take a considerable time, especially if all the data needs to be keyed in, and must be planned carefully - for example, the creation of the inventory for a spare parts control system or the opening balances for each line of an accounting system. The system should only be installed if the results of the system tests are correct. Adequate training of the staff is essential. Installation is a busy time and often an old system must be run in parallel with the new one for final validation. It is a time of change and people are apprehensive. Therefore a time should be chosen when no other task demands urgent attention from the staff. The period for parallel running will depend on the complexity of the system and on the frequency of the processing; for example, with on-line processing, validation may be done over a relatively short period, while a monthly payroll system may require parallel running for two or three months. Make a plan for the installation and ensure that everybody involved understands their part.

E. Monitoring the operation of the system

89. A common failing of information systems including computer applications is that they remain static after being implemented. Feedback on the system's performance is essential to make sure that it continues to serve the company's interests. Requests for changes are a good indication that the system is being used and adapting to a changing environment. A new system should be regularly monitored to ensure that it is genuinely effective. The impact of a computer based information system extends well beyond its immediate working environment. It may cause changes in the way that the organization conducts its business. It may affect the working practices of other departments and external organizations who receive information generated by the system.

90. The attitudes of users to the system can change and bring about a greater enthusiasm for the system or alternatively a total rejection of it. It is therefore important to monitor the behaviour of both direct users of the system, such as managers and data-entry staff, and those end users who either provide information for the system or receive information generated by it.

91. The performance of a computerized information system may, depending on the type and scope of the system, be measured at various levels of activity within the company, for example:

- the organizational level - the effect of the system on the organization in which it works;
- the information system level - the achievement of the objectives of the system;

- levels within the system, for example:

  - user satisfaction with the system,
  - software quality,
  - hardware reliability and performance.

Some of the questions which might be asked are for example:

- are the stated objectives being met?
- are the objectives still relevant?
- have clients expressed views on the new system?
- does the system process all the information that it should?
- is the system providing up-to-date information?
- how many errors are being detected in the incoming information?
- is the security of data within the system adequate and is there proof that it has been checked?
- during what percentage of normal operating time has the system been unavailable for use?
- what has been the average downtime period?
- what fraction of downtime has been caused by software problems?

92. A procedure should be set up for gathering and analysing the relevant information to monitor system performance. At the operational level, a formal reporting system of key parameters such as downtime, equipment repairs and software faults would provide the information necessary for the statistical analysis of the system. This would normally be operated by the persons responsible for managing the system, either user or technical staff.

93. Evaluating the performance of the system at the user level may require different techniques. Observation of users' behaviour can often indicate where the system requires further detailed examination. Alternatively, interviews with users to obtain their opinions of the system and their mode of work can reveal performance problems as well as suggestions for improvement.

94. Monitoring the system and evaluating its performance is a part of its operation, and should be planned. An important aspect of the monitoring procedure is to identify any under-utilization of the system. Some information systems are heavily used for short periods and relatively inactive at other times. Monitoring use of the system as well as performance can reveal a poorly utilized system that could be improved. Alternatively the system could be used for other activities during these inactive periods. When problems arise with the performance of the system it is necessary to report them, isolate them and see that action is taken. Thus it is important that there are clear guidelines on responsibilities for system performance.

VI. Conclusions

95. Port managers who are not already using computers as an aid to managing their business should consider doing so. There are several reasons for considering this matter now: other ports in the world have been using computers for many years with benefit; the cost of using computers continues to fall so that the net benefit tends to increase; many of a port's customers, particularly shipping companies, are using computers so that information which previously required expensive manual processing is now available for direct input to port computer systems (for controlling operations, invoicing, etc.); less and less technical knowledge and experience are required to make use of computers, particularly microcomputers, so that the port manager using computers is less dependant on scarce technical skills. Also, the provision of a good telecommunications facility in the immediate vincinity of the port area which will allow the linking of computers is an important factor for the effective planning of ship working and cargo dispatch, thus making the port more competitive.

96. Port organizations already using computers should review the possibilities of developing new applications and of improving old ones. This report gives a conceptional overview of a selection of computer information systems in use in many ports in the world which could form the basis of such a review. The possibility of using microcomputers should also be considered in view of their advantages, such as low cost of both hardware and software, user friendliness, reliability, standardization of hardware and software and the ability to site them in user's departments.

97. Port managers should review the role that their port should play in the processing and transmission of information related to cargo and shipping. Expert advice may be needed for this review because the topic is complex and depends on national policy as well as international agreements. Other organizations (customs, freight forwarders, banks) are involved besides those involved in the physical movement of the cargo. Port managers need to consider their relationships with all other users of this information to ensure both that they get all the information that they need and also that the port occupies an appropriate place in the processing and transmission of information related to the cargo that it handles. This could extend in some cases to providing a central databank for use by other organizations involved, including ships agents, road haulage and railways. The port is the focal point for the physical handling and checking of cargo and is the logical focal point for centralizing information as well.

98. Implementation of computer systems is inevitable and thus a development plan for long-term management information needs should be drawn up by the port organization. The plan should specify centralized control for the purchase of hardware and software to ensure compatibility. This will facilitate the exchange of information, initially via diskettes and eventually via networks.

99. The development of computerized information systems is a task in which both the technician and the manager must participate: managers need specialist advice which should be obtained from an expert, either an external consultant or a suitably trained and experienced local specialist. It is essential to proceed with discipline, much in the manner described in this report. Finally, the development of computerized systems gives an opportunity to review and revise organizational structure and existing information systems, which alone can often lead to substantial savings in time, effort and money.

Annex I
PRACTICAL EXAMPLE OF A CONTAINER TERMINAL SYSTEM

1. General characteristics of Baltic Container Terminal (Gdynia)

The container terminal at the Port of Gdynia has been designed for a maximum throughput of 170,000 TEU's a year and had 120,000 TEU's movements in 1989. The terminal operator is the Baltic Container Terminal with a staff of 500 employees and is part of the Port of Gdynia organization. There are two lo-lo and two ro-ro berths for ship loading and discharging operations. The marshalling area characteristics are as follows:

- total area - 40 hectares;
- stacking area capacity - 9 hectares (10,000 TEU);
- ro-ro area - 1.5 hectares;
- 200 points for reefer containers.

Container handling equipment consists of three 45-ton ship-to-shore gantry cranes, seven 31-ton rubber tyred yard gantries, seven 30.5-ton straddle carriers and two 15-ton mobile cranes. There is a container freight station (CFS) of 20,000 m^2 for stripping and stuffing of containers and a two track railway terminal equipped with two 35-ton railway transtainers.

2. Objective and scope of system

The objective of the system is to assist operational sections of the terminal in their day-to-day work. The system provides complete, timely and consistent information, thus giving better service to terminal users. The main tasks can be described as follow:

- to keep an up-to-date record of each container from the moment of entering until the moment of leaving the terminal;
- to keep a record of the detailed location of each container in the yard area and provide an overview of the situation in the yard;
- to keep records of cargo passing through the CFS;
- to provide on-line informations for operational purposes as well as producing periodic reports and analysis.

The main users of the system are the operational sections from the terminal and companies involved in container transport. The users from the terminal are: Yard Section - responsible for the movements of containers in the yard; Documentation Section - responsible for current handling of documents related to containers movement; and Container Freight Station staff - responsible for the movement and control of cargo in the CFS. Other companies using the system are the forwarding agency - involved in the organization of transport of a large portion of the containers passing through the terminal, shipping companies having liner services from Gdynia and the Customs office at Gdynia.

The system is run at the Port of Gdynia Computer Center on a PDP 11/44 minicomputer and requires at least 200 Megabytes of disk storage capacity, 600 lpm printer and 15 visual display units (vdu) which allows various users in different locations to have simultaneous access to the system, either to input data or retrieve information. Six vdu's are in the Yard Section, four in the Documentation Section, two in the CFS, two in the forwarding agency and one in the computer center for overall technical management of the system.

In addition to the vdu's, a communication link for computer-to-computer transmission is available. The link is a dial-up, temporary connection from external PC microcomputers (other type of computers can also be connected) to the port system. The PC may work either as ordinary terminal (vdu) or transmit batches of information. In this manner, ship's manifests, loading lists and/or other data can be easily transmited or exchanged between port and other companies. The Kermit communication package is applied for this purposes. The number of vdus and communication links can be easily increased as needs grow.

The system had been designed, programmmed and installed by Computer Center staff from the Port of Gdynia. The software was developed using COBOL and work started at the end of 1985. Two experienced analyst-programmers worked for one year and three programmers with moderate experience worked for 6 months to develop the system including implementation. The

system works in an *on-line* manner and is available 22.5 hours per day. One and half hours are required during the night shift to produce periodical reports and to perform file security procedures.

3. Organization of the system

The system consists of three autonomous but complementary modules: documentation, container yard and CFS.

Documentation module

The principal task of the module is to assist the Documentation Section in recording and keeping up-to-date all the basic information coming from documents related to the movement of containers. Customer orders, ship's manifests, and cargo lists (loading dispositions) are the principal source documents here.

The heart of the module is the main container file in which a separate record is maintained for each container in the terminal. All required information is kept within the record. Once the container leaves the terminal, its record is moved into an on-line archive file where it is kept for 12 months for the preparation of statistics and then transferred to an off-line file where it is kept for a further 48 months for possible claims. The basic data elements within the main container file are the following:

- general data:
  - container number;
  - size/type;
  - port receipt number;
  - customer order numbers;
  - customer/agent responsible for container;
  - forwarding agent's reference number;
  - container condition.
- receipt/delivery data:
  - date;
  - direction (import/export);
  - vehicle identification;
  - vessel/voyage/line identification;
  - loading/discharging port involved;
  - technology (ro-ro/lo-lo);
  - trailer number, if applicable.
- cargo description:
  - description of cargo;
  - dangerous cargo code and class if any;
  - gross and net weights;
  - seal number;
  - fcl/lcl identification.

Container yard module

The main user of the module is the yard section for the direct control and recording of all movements of containers within the yard. The yard area is organized in blocks of containers which normally consists of 6 columns, 16 rows, and 4 layers. The position of a container in the yard is identified by a block number, column number, row number and the layer number. The layouts of the blocks are predefined in the system's memory. The system assures that movements of containers are in agreement with particular block layouts and in accordance with basic rules (for example, a container cannot be placed in an upper layer if there is nothing beneath, a 40-foot unit cannot be placed over one 20-foot unit, etc.).

Simultaneously to updating the position of a container, a log of all movements carried out by each equipment operator is maintained and may be printed for control purposes. The main

information kept within the files is the mirror image of the layout of containers in the yard. This module updates the receipt and delivery dates of containers in the documentation module and can be accessed by the Documentation Section to determine the location of containers in the yard.

CFS module

This module is used by the CFS manager, mainly to keep records of all goods received to and delivered from the CFS. The operations do not differ from standard stores management, except that the stripping or stuffing status of the container is recorded in the documentation file. All movements of cargo through the shed are carried out based upon customer orders. The registers of such orders are also maintained within the module. Basic information kept in the files is the following:

- dates of movements;
- port receipt number;
- customer order number;
- description of the cargo;
- marks and numbers;
- type of packing;
- quantity and weight;
- customer/agent responsible;
- container number;
- vessel name;
- B/L number;
- cargo locations in the CFS.

4. Outputs of the system

Screens

- container records from the documentation file;
- customer orders registers;
- layout of containers in the block;
- loading/discharging lists;
- cargo in the CFS.

Reports

- Daily:
  - customer's orders register;
  - port receipts register;
  - containers left/received;
  - transit shed in/out cargo movement list;
  - log of the yard operations executed;
  - lists of stuffed/stripped containers.

- According to ships calls:
  - containers discharged from the ship;
  - manifest discrepancy report (comparison of the manifest against list of discharged containers);
  - port receipts printout for discharged containers;
  - list of trailers loaded with containers;
  - containers loaded on board;
  - LCL containers loaded on board.

- On request:
  - list of containers in the yard according to selected parameters (owner prefix, size/type, customer responsible, etc.);
  - containers in the yard stored longer than given number of days;
  - list of containers with dangerous cargo;
  - loading/discharging lists for railways wagons;
  - list of cargo in CFS by storage position.

- Weekly:
  - cargo delivered from CFS.

- Monthly:
  - yard inventory (partial printout for periodical checking purposes);
  - CFS inventory;
  - statistics (number of containers and dwell time analysis).

5. Further development of the system

The immediate plans call for integration of the system with existing invoicing system. Efficiency of invoicing is expected to increase significantly as the daily number of container invoices varies from 300 to 400.

There are also further plans to provide for radio transmission of data between the computer and yard mobile equipment (mainly all gantries and straddle carriers). The objective is to send the sequences of operations to be performed directly from the computer to the driver's cabin and also to allow the driver to have an up to date record of the positions of containers.

Annex II
CONTROLS AND STANDARDS

1. Controls

Controls are the only way to provide security and reliability in the information system. A good computerised management information system will not lose or corrupt information and it will not allow unauthorised persons access to information. The quality of the information entering the system must be controlled. Usually a computer program is used to check input data to ensure that it is within pre-specified ranges and consistent.

Information in files can be misplaced, corrupted (intentionally or unintentionally altered), accessed by unauthorised persons and files can be lost or destroyed. The most important file in the system is usually called the master file. It is the file which is updated and from which the reports are produced. There must be a system to ensure that if the latest copy of the master file is damaged or lost then it can be recreated. In an on-line system the transactions used to update files will be recorded so that if breakdown occurs then the recorded transactions can be used to bring the files back to the state just before the breakdown occurred.

It may seem that there is not so much that can go wrong with reports, but even if the rest of the system is fine it is possible to give a report based on out-of-date information or incomplete information. Reports should normally therefore have a date of production and page-number on each page. Information which identifies the master file from which the report was produced should also be given.

2. Standards

Various kinds of standards exist. There are internationally recognised standards - particularly those for data transmission and coding, for example, ship codes from Lloyd's Register of Ships, LOCODE - maritime port codes, container size and type codes, etc. There are national standards, some of which are widely used internationally. There are industry standards often used in a group of countries and there are *de facto* standards which exist because one supplier has a very large part of the market so that others find it worthwhile to make equipment or software which conforms to the design of the dominant supplier. When considering new information systems make sure that they conform with the relevant standards whenever possible. The use of standards will generally facilitate maintenance, operation, training for the people using the system, expansion of the system, replacement of the equipment and communication with other internal and external systems. However the pace of change, particularly of microcomputer hardware and telecommunications equipment is so rapid that what is a *de facto* standard today may be obsolete next year. International, national and industry standards evolve more slowly.

Compatibility is important as hardware is evolving so rapidly that in five years it is usually possible to obtain benefits by replacing hardware (cheaper, faster and less maintenance). Also compatibility is required when additional equipment has to be purchased and when it becomes necessary to exchange information between different systems. Only with microcomputers can we really consider hardware standards. With mainframe and mini-computers each main manufacturer goes his own way and the smaller ones make *plug compatible* equipment which can be used to replace the main manufacturers' equipment.

Software is not nearly so standardised as hardware, but as the hardware becomes cheaper software will become more and more important because organisations will not be able to afford the high and increasing cost of changing software when they change hardware. The possibility and the cost of transferring existing software is critical when considering changing hardware. The portability of software between machines is an important factor to consider when selecting new equipment. The operating system used is the most important factor and the Unix operating system is a development to facilitate the interchange of software.

General purpose packages such as Lotus123, Wordstar and dBaseIII are widely used for producing application software on personal computers which is cheap and fairly flexible. For minicomputers, apart from those offered by computer manufacturers, there is a growing number of database packages, the most popular ones are Informix, Oracle and Ingres. These packages provide a cost-effective way to produce adequate software quickly.

Systems exist which allow several computers of different types to be interconnected to use a common database, to share resources and to be connected via telephone lines to remote systems and databases. Larger computer manufacturers have developed standards and efficient and complex packages for sharing resources and exchanging information. For personal computers networks there is a large choice and it is difficult to make any general statements.

Telecommunication standards, also known as protocols, are simply rules to avoid misunderstandings when transmitting data between two computers. Thus a protocol is a set of rules to make sure that one device will send characters only when the other is able to receive them. A protocol will include speed of transmission, how to establish connections, how to frame data, how to check for errors and how to correct errors.

For the facilitation of international trade, an internationally recognised standard for the electronic data interchange (EDI) of information between computers is being developed. An international group working on the United Nations Rules for Electronic Data Interchange For Administration, Commerce and Transport (UN/EDIFACT) has produced syntax rules which have been adopted by the International Organization for Standardization (ISO). An EDIFACT message is made up of standard data elements which in turn are grouped into logical standard segments. A data element is the smallest indivisible piece of data such as a date or an invoice number and is chosen from the United Nations Trade Data Elements Directory (UNTDED)[1] which includes more than 600 data element grouped into nine broad categories.

A message consists of a number of standard segments which are transmitted for performing a specific business or administrative function. For transport a number of messages are being developed: International Forwarding and Transport Message Framework (IFTMFR), Provisional Booking, Firm Booking, Booking Confirmation, Instruction, Instruction Contact Status, Arrival Notice, Manifest and EDIMAR.

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1 Copies of the United Nations Trade Data Elements Directory are available from the United Nations Sales Section, Palais des Nations, CH-1211 Geneva 10.